## IT@Intel Brief

**Intel IT**
Business Solutions
IT Efficiency and Employee Productivity
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# Increasing Design Throughput with Workstations Based on Intel® Xeon® Processor 5600 Series

- Up to 4.75x performance increase.
- Enables increase in design engineer productivity.
- Potential for faster time to market and quality improvements.

In Intel IT tests simulating the daily workflow of a silicon design engineer, a workstation based on the new Intel® Xeon® processor 5600 series completed multiple, concurrent electronic design automation (EDA) application workloads up to 4.75x faster than a workstation based on Intel® Xeon® processor 5100 series and up to 1.37x faster than a workstation based on Intel® Xeon® processor 5500 series. Performance comparisons are shown in Figure 1.

In our tests, each system completed a total of 24 jobs, using multiple front-end and back-end EDA applications operating on real Intel silicon design workloads. With a total of 12 processor cores, the workstation based on Intel® Xeon® processor X5680 provided higher throughput by running 12 jobs concurrently and completing them more quickly.

High-performance workstations based on the Intel Xeon processor 5600 series let engineers create and test designs more quickly using multiple EDA applications concurrently. This allows faster design iterations with more-demanding design workloads, accelerating product time to market. It also allows more validation cycles, enabling improvements in product quality.

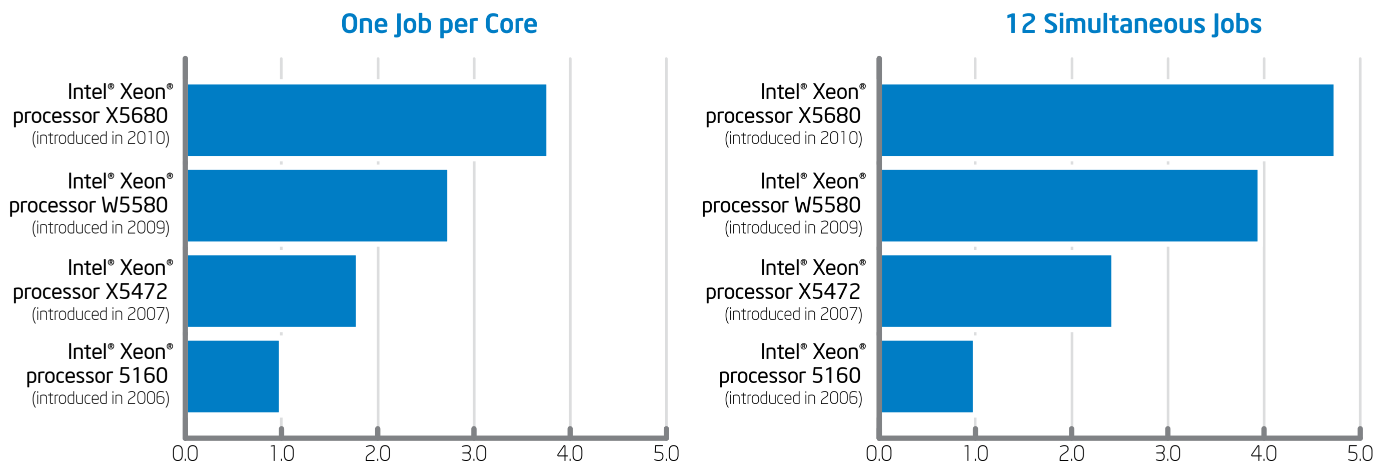


Figure 1. Relative performance of dual-socket workstations running multiple front-end and back-end electronic design automation (EDA) applications.
Based on Intel IT tests applying two different usage approaches: a) one job per core, and b) 12 simultaneous jobs. Intel internal measurements, June 2010.

## Business Challenge

Design engineers at Intel face the challenges of integrating more features into ever-shrinking silicon chips, bringing products to market faster, and keeping design engineering and manufacturing costs low.

In a typical workday, each design engineer works simultaneously on several of the functional blocks of a silicon design. For each block, the engineer uses an iterative design method in which each front-end (logical) design stage is followed by a corresponding back-end (physical) design stage, as shown in Figure 2. Each of these design stages is supported by EDA applications that run on engineering workstations based on Intel® Xeon® processors. Each application workload is processor-intensive and can take from several minutes to hours to complete.

In the past, design engineers staggered design tasks due to limitations in the number of processor cores, CPU speed, and memory capacity of each workstation.

However, as processor performance has increased, a new category of workstations has emerged, based on the Intel Xeon processor 5600 series. These act as expert workbenches, allowing engineers to more quickly create and test design ideas by running suites of multiple front-end and back-end EDA applications concurrently.

The Intel Xeon processor 5600 series, based on 32-nm process technology, includes up to six cores per processor, with features to maximize performance such as Intel® Turbo Boost Technology, Intel® QuickPath Interconnect, and Intel® Hyper-Threading Technology.

Dual-processor workstations based on the Intel Xeon processor 5600 series include RAM capacity of up to 288 GB (with 16-GB DIMMS, using 18 memory slots) to support more-demanding workloads and run more EDA applications simultaneously.

To evaluate the impact on design engineers' productivity, we performed tests to compare a workstation based on Intel Xeon processor 5600 series with workstations based on previous processor generations.

## Test Methodology

We compared four dual-processor workstations, each based on a different processor generation.

- **Intel® Xeon® processor 5160-based workstation.** This workstation included two dual-core processors, based on 65 nm process technology, for a total of four cores.
- **Intel® Xeon® processor X5472-based workstation.** This workstation included two quad-core processors, based on 45 nm process technology, for a total of eight cores.
- **Intel® Xeon® processor W5580-based workstation.** This workstation included two quad-core processors, based on 45 nm process technology, for a total of eight cores.
- **Intel Xeon processor X5680-based workstation.** This workstation included two six-core processors, based on 32nm process technology, for a total of twelve cores.

Test system specifications are shown in Table 1.

We designed our tests to represent a typical workday, in which a silicon design engineer is working on multiple design tasks concurrently, using front-end and back-end design applications.

Our goal was to compare the design throughput of each workstation by measuring the time required to complete a total of 24 silicon design jobs: 12 front-end jobs and 12 back-end jobs.

Our tests used industry-leading 32-bit and 64-bit front-end (logic simulation) and back-end (design rule check) EDA applications operating on real Intel® processor and chipset design workloads.

To analyze throughput under different loads, we conducted two sets of tests on each workstation. Each set of tests represented a commonly used approach to running silicon design jobs.

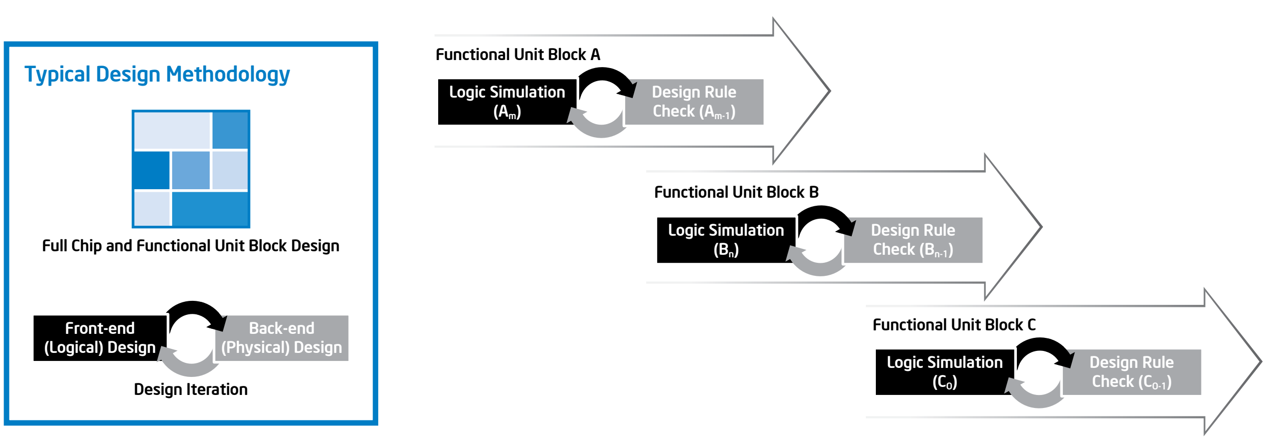


Figure 2. Day in the life of a silicon design engineer. An engineer typically works simultaneously on several of the functional blocks in each silicon design; each block is designed using an iterative process supported by front-end and back-end electronic design automation (EDA) applications.

### ONE JOB PER CORE

We ran one concurrent job or application process per physical core. An engineer may use this approach in order to maximize the raw performance of individual applications. In our tests, this resulted in sets of four to 12 concurrent jobs, depending on the number of cores. When each set had completed, we submitted the next set of four to 12 jobs. We continued this process until the workstation had completed all 24 jobs.

### 12 CONCURRENT JOBS

An engineer may not be aware of the number of physical cores in a given workstation and may submit all front-end or back-end jobs at the same time. To represent this usage model, we first ran 12 simultaneous front-end jobs on each workstation. When all 12 front-end jobs had completed, we submitted the 12 back-end design jobs.

## Results

The Intel Xeon processor X5680-based workstation completed the tests up to 4.75x faster than the workstation based on Intel Xeon processor 5160 and up to 1.37x faster than the workstation based on Intel Xeon processor W5580.

### ONE JOB PER CORE

In the tests with one job per core, the Intel Xeon processor X5680-based workstation completed the 24 jobs 3.78x faster than the workstation based on Intel Xeon processor 5160 and 1.37x faster than the workstation based on Intel Xeon processor W5580, as shown in Table 2.

With a total of 12 cores, the Intel Xeon processor X5680-based workstation was able to run 12 jobs concurrently with good performance, and therefore completed the 24 jobs in fewer steps than the other workstations. This resulted in a faster overall completion time.

Table 1. Test System Specifications

| | Intel® Xeon® Processor 5100 Series | Intel® Xeon® Processor 5400 Series | Intel® Xeon® Processor 5500 Series | Intel® Xeon® Processor 5600 Series |
|---|---|---|---|---|
| Processor | 2x Intel® Xeon® processor 5160 | 2x Intel® Xeon® processor X5472 | 2x Intel® Xeon® processor W5580 | 2x Intel® Xeon® processor X5680 |
| Cores per Processor | 2 | 4 | 4 | 6 |
| Speed | 3.0 GHz | 3.0 GHz | 3.2 GHz | 3.33 GHz |
| Intel® Turbo Boost Technology | N/A | N/A | Enabled | Enabled |
| Intel® Hyper-Threading Technology | N/A | N/A | Disabled | Disabled |
| Chipset | Intel® 5000X Chipset | Intel® 5400 Chipset | Intel® 5520 Chipset | Intel® 5520 Chipset |
| Interconnects | 1333 MHz Front-side Bus (FSB) | 1600 MHz FSB | 6.4 GT/s Intel® QuickPath Interconnect | 6.4 GT/s Intel QuickPath Interconnect |
| RAM | 32 GB (8x 4 GB) | 32 GB (8x 4 GB) | 48 GB (12x 4 GB) | 48 GB (12x 4 GB) |
| RAM Type | DDR2-667/Fully Buffered DIMM | DDR2-667/Fully Buffered DIMM | DDR3-1333 MHz (operating at 1066 MHz) | DDR3-1333 MHz |
| Hard Drive | 500 GB, 7200 RPM SATA 3.0 Gb/s | 500 GB, 7200 RPM SATA 3.0 Gb/s | 500 GB, 7200 RPM SATA 3.0 Gb/s | 500 GB, 7200 RPM SATA 3.0 Gb/s |
| OS | 64-bit Linux* | 64-bit Linux | 64-bit Linux | 64-bit Linux |

Table 2. Relative Performance and Runtimes when Running One Job per Core

<table>
<tr><th>Workload</th><th>Peak Memory Used</th><th>Intel® Xeon® Processor 5160<br>4 Jobs per Set<br>6 Steps</th><th>Intel® Xeon® Processor X5472<br>8 Jobs per Set<br>3 Steps</th><th>Intel® Xeon® Processor W5580<br>8 Jobs per Set<br>3 Steps</th><th>Intel® Xeon® Processor X5680<br>12 Jobs per Set<br>2 Steps</th></tr>
<tr><td>Logic Simulation Tool B (4 Jobs)</td><td>9 GB</td><td>0:34:29</td><td rowspan="2">0:52:37</td><td rowspan="2">0:27:42</td><td rowspan="3">0:32:57</td></tr>
<tr><td>Logic Simulation Tool B (4 Jobs)</td><td>9 GB</td><td>0:36:41</td></tr>
<tr><td>Logic Simulation Tool B (4 Jobs)</td><td>9 GB</td><td>0:39:49</td><td rowspan="2">0:41:58</td><td rowspan="2">0:31:48</td></tr>
<tr><td>Design Rule Check - Tool C (4 Threads)</td><td>2.7 GB</td><td>0:43:09</td><td rowspan="3">0:39:24</td></tr>
<tr><td>Design Rule Check - Tool B<br>(2 Distributed Processes x 2 Threads)</td><td>1.8 GB</td><td>0:56:05</td><td rowspan="2">0:57:26</td><td rowspan="2">0:39:44</td></tr>
<tr><td>Design Rule Check - Tool B<br>(2 Distributed Processes x 2 Threads)</td><td>1.5 GB</td><td>1:03:05</td></tr>
<tr><td>Total Runtime</td><td></td><td>4:33:18</td><td>2:32:01</td><td>1:39:14</td><td>1:12:21</td></tr>
<tr><td>Relative Performance</td><td></td><td>1.00</td><td>1.80</td><td>2.75</td><td>3.78</td></tr>
</table>

Note: The reported times are the maximum job runtimes observed within each step

Table 3. Relative Performance and Runtimes when Running 12 Simultaneous Jobs

| Workload | Peak Memory Used | Intel® Xeon® Processor 5160 | Intel® Xeon® Processor X5472 | Intel® Xeon® Processor W5580 | Intel® Xeon® Processor X5680 |
|---|---|---|---|---|---|
| Logic Simulation Tool B (12 Jobs) - Set 1 | 27 GB | 3:33:43 | 1:16:54 | 0:44:19 | 0:32:57 |
| Design Rule Check - Tool B, C (12 Jobs) - Set 2 | 6 GB | 2:10:18 | 1:03:56 | 0:42:28 | 0:39:24 |
| Total Runtime | | 5:44:01 | 2:20:50 | 1:26:47 | 1:12:21 |
| Relative Performance | | 1.00 | 2.44 | 3.96 | 4.75 |

Note: The reported times are the maximum job runtimes observed within each step

### 12 CONCURRENT JOBS

In the tests with 12 concurrent jobs on each system, the Intel Xeon processor X5680-based workstation completed the 24 jobs 4.75x faster than the workstation based on Intel Xeon processor 5160 and 1.2x faster than the workstation based on Intel Xeon processor W5580, as shown in Table 3.

On the Intel Xeon processor X5680-based workstation, this test procedure resulted in one job per core. However, on the other three workstations, the cores were oversubscribed—with 12 concurrent jobs, there were 1.5x to 3x as many jobs as cores. This resulted in slower completion times, especially on the Intel Xeon processor 5160-based workstation, which had only four cores.

## Conclusion

The availability of workstations based on Intel Xeon processor 5600 series has broad implications for silicon design. In the past, design engineers staggered design tasks due to limitations in processing power and the number of cores available. Now, design engineers can run more jobs concurrently with good performance. In addition, each processing core offers faster performance, reducing total design time.

This allows engineers to analyze the results of each design stage sooner, make necessary design changes, and quickly run the next design iteration. This results in increased design engineer productivity, which enables faster semiconductor product design. Engineers can also run more validation cycles, identifying problems earlier in product development to improve quality.

Our results suggest that other technical applications with large memory requirements, such as simulation and verification applications in the auto, aeronautical, oil and gas, and life sciences industries, could see similar improvements.

Based on our test results, we are establishing workstations based on Intel Xeon processor 5600 series as our standard for Intel IT internal workstation deployments, including refreshes of older systems.

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